HUMAN-COMPUTER INTERACTION THIRD EDITION DIX FINLAY ABOWD BEALE

Chapter 10

Universal design

1

Universal design principles

- NCSW

- Equitable use (design is useful to people with a range of abilities and appealing to all)
- Flexibility in use (through different methods of use and adaptivity)
- Simple and intuitive to use
- Perceptible information (effective communication with the user regardless of his abilities or environmental issues)
- Tolerance for error
- Low physical effort
- Size and space for approach and use by user

2

Multi-sensory systems

- More than one sensory channel in interaction
  - e.g. sounds, text, hypertext, animation, video, gestures, vision
- Used in a range of applications:
  - particularly good for users with special needs, and virtual reality
- Will cover
  - general terminology
  - speech
  - non-speech sounds
  - handwriting
- Considering applications as well as principles

3

Usable senses

The 5 senses (sight, sound, touch, taste and smell) are used by us every day
- each is important on its own
- together, they provide a fuller interaction with the natural world

Computers rarely offer such a rich interaction

Can we use all the available senses?
- ideally, yes
- practically – no

We can use • sight • sound • touch (sometimes)

We cannot (yet) use • taste • smell

4

Multi-modal vs. Multi-media

- Multi-modal systems
  - use more than one sense (or mode) of interaction
    e.g. visual and aural senses: a text processor may speak the words as well as echoing them to the screen
- Multi-media systems
  - use a number of different media to communicate information
    e.g. a computer-based teaching system may use video, animation, text and still images; different media all using the visual mode of interaction; may also use sounds, both speech and non-speech; two more media, now using a different mode

5

Speech

Human beings have a great and natural mastery of speech

- makes it difficult to appreciate the complexities

but

- it's an easy medium for communication

6

Structure of speech

Phonemes
- 40 of them
- basic atomic units
- sound slightly different depending on the context they are in, these larger units are …

Allophones
- all the sounds in the language
- between 120 and 130 of them
- these are formed into …

Morphemes
- smallest unit of language that has meaning

7

Speech (ctd)

Other terminology:
- prosody
  - alteration in tone and quality
  - variations in emphasis, stress, pauses and pitch
  - impart more meaning to sentences
- co-articulation
  - the effect of context on the sound
  - transforms the phonemes into allophones
- syntax – structure of sentences
- semantics – meaning of sentences

8

Speech Recognition Problems

- Different people speak differently:
  - accent, intonation, stress, idiom, volume, etc.
- The syntax of semantically similar sentences may vary
- Background noises can interfere
- People often "ummm….." and "errr….."
- Words not enough - semantics needed as well
  - requires intelligence to understand a sentence
  - context of the utterance often has to be known
  - also information about the subject and speaker

e.g. even if "Errr.... I, um, don't like this" is recognised, it is a fairly useless piece of information on its own

9

The Phonetic Typewriter

- Developed for Finnish (a phonetic language, written as it is said)
- Trained on one speaker, will generalise to others
- A neural network is trained to cluster together similar sounds, which are then labelled with the corresponding character
- When recognising speech, the sounds uttered are allocated to the closest corresponding output, and the character for that output is printed
  - requires large dictionary of minor variations to correct general mechanism
  - noticeably poorer performance on speakers it has not been trained on

10

The Phonetic Typewriter (ctd)

a a a ah h æ æ ø ø e e e
o a a h r æ l ø y y j i
o o a h r r r g g y j i
o o m a r m n m n j i i
l o u h v vm n n h hj j j
l u v v p d d t r h hi j
. . u v tk k p p p r k s
. . v k pt t p t p h s s

11

Speech recognition: useful?

- Single user or limited vocabulary systems
  e.g. computer dictation
- Open use, limited vocabulary systems can work satisfactorily
  e.g. some voice activated telephone systems
- general user, wide vocabulary systems … … still a problem
- Great potential, however
  - when users' hands are already occupied
    e.g. driving, manufacturing
  - for users with physical disabilities
  - lightweight, mobile devices

12

Speech synthesis

The generation of speech

Useful
- natural and familiar way of receiving information

Problems
- similar to recognition: prosody particularly

Additional problems
- intrusive - needs headphones, or creates noise in the workplace
- transient - harder to review and browse

13

Speech synthesis: useful?

Successful in certain constrained applications when the user:
- is particularly motivated to overcome problems
- has few alternatives

Examples:
- screen readers
  - read the textual display to the user utilised by visually impaired people
- warning signals
  - spoken information sometimes presented to pilots whose visual and haptic skills are already fully occupied

14

Uninterpreted speech

Speech does not have to be recognized by a computer to be useful in an interface

Fixed pre-recording messages can be used to supplement or replace visual information

Segments of speeches can be used together to construct messages

15

Uninterpreted speech: useful?

- Announcements in airports, railway stations, etc.
- Collaborative applications such as voicemail systems
- As audio annotations attached to other artifacts (e.g. Word documents)
- To speed up the communication between an operator for a telephone help line and an enquirer

16

Non-speech sounds

boings, bangs, squeaks, clicks, etc.

- Commonly used for warnings and alarms
- Evidence to show they are useful
  - fewer typing mistakes with key clicks
  - video games harder without sound
- Language/culture independent, unlike speech

17

Non-speech sounds: useful?

- Dual mode displays:
  - information presented along two different sensory channels
  - redundant presentation of information
  - resolution of ambiguity in one mode through information in another
- Sound good for
  - transient information
  - background status information

e.g. Sound can be used as a redundant mode in the Apple Macintosh; almost any user action (file selection, window active, disk insert, search error, copy complete, etc.) can have a different sound associated with it

18

Auditory icons

- Use natural sounds to represent different types of object or action
- Natural sounds have associated semantics which can be mapped onto similar meanings in the interaction
  e.g. throwing something away
  ~ the sound of smashing glass
- Problem: not all things have associated meanings
- Additional information can also be presented:
  - muffled sounds if object is obscured or action is in the background
  - use of stereo allows positional information to be added

19

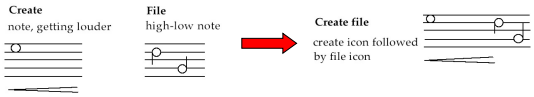
SonicFinder for the Macintosh

- Items and actions on the desktop have associated sounds
- Folders have a papery noise
- Moving files – dragging sound
- Copying – a problem …
  sound of a liquid being poured into a receptacle
  rising pitch indicates the progress of the copy
- Big files have louder sound than smaller ones

20

Earcons

- Synthetic sounds used to convey information
- Structured combinations of notes (motives) represent actions and objects
- Motives combined to provide rich information
  - compound earcons
  - multiple motives combined to make one more complicated earcon



21

Earcons (ctd)

- Family earcons
  similar types of earcons represent similar classes of action or similar objects: the family of "errors" would contain syntax and operating system errors

Earcons easily grouped and refined due to compositional and hierarchical nature

Harder to associate with the interface task since there is no natural mapping

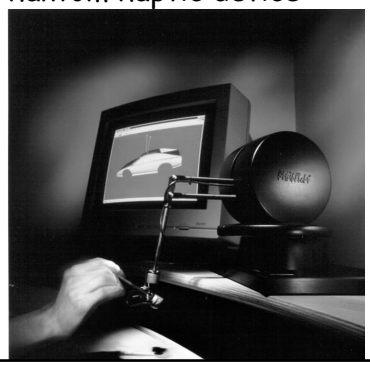
22

Touch

- Haptic interaction
  - cutaneous perception
    - tactile sensation; vibrations on the skin
  - kinesthetics
    - movement and position; force feedback
- Information on shape, texture, resistance, temperature, comparative spatial factors
- Example technologies
  - electronic braille displays
  - force feedback devices e.g. Phantom
    - allows the user to feel resistance, texture, friction

23

A Phantom haptic device



24

Handwriting recognition

Handwriting is another communication mechanism which we are used to in day-to-day life

- Technology
  - handwriting consists of complex strokes and spaces
  - captured by digitising tablet
    - strokes transformed to sequence of dots
  - large tablets available
    - suitable for digitising maps and technical drawings
  - smaller devices, some incorporating thin screens to display the information
    - PDAs such as Palm Pilot
    - tablet PCs

25

Handwriting recognition (ctd)

- Problems
  - personal differences in letter formation
  - co-articulation effects (different letters are written differently, according to the preceding and successive ones)
- Breakthroughs:
  - stroke not just bitmap
  - special 'alphabet' – Graffeti on PalmOS
- Current state:
  - usable – even without training
  - but many prefer keyboards!

26

Gesture

- Applications
  - gestural input - e.g. "put that there"
  - sign language
- Technology
  - data glove
  - position sensing devices e.g MIT Media Room
- Benefits
  - natural form of interaction - pointing
  - enhance communication between signing and non-signing users
- Problems
  - user dependent, variable and issues of coarticulation

27

Users with disabilities

- Visual impairment
  - screen readers, SonicFinder
- Hearing impairment
  - text communication, gesture, captions
- Physical impairment
  - speech I/O, eyegaze, gesture, predictive systems (e.g. Reactive keyboard)
- Speech impairment
  - speech synthesis, text communication
- Dyslexia
  - speech input, output
- Autism
  - communication, education

28

Reactive keyboard commands

```
$ mail                                                    ↑N
  cd news                                                 ↑W
  cd news                                                 ↑N
  cd rk/papers/ieee.computer                              ↑L
  cd rk/papers/ieee.computer

$ emacs paper.tex                                         ↑L
  emacs paper.tex

$ rm paper.tex.CKP paper.tex.BAK                          ↑L
  rm paper.tex.CKP paper.tex.BAK

$ wc -w paper.tex                                         ↑L
  wc -w paper.tex

$ readnews -n comp.sources.unix                           ↑N
  mail                                                    ↑W
  mail                                                    ↑N
  mail bdarragh%uncamult.bitnet@ucnet.ucalgary.c          ↑L
  mail bdarragh%uncamult.bitnet@ucnet.ucalgary.c
```

User's dialog with the Reactive keyboard.
Only the last line in each group is actually executed.

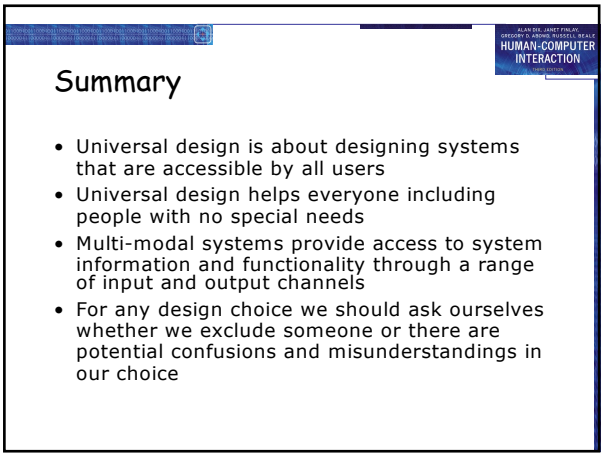
Key	Description
↑C (control-C)	Accept the next predicted character
↑W	Accept the next predicted word
↑L	Accept the whole predicted line
↑N	Show the next alternative prediction
↑P	Show the previous alternative prediction

29

… plus …

- Age groups
  - older people e.g. disability aids, memory aids, communication tools to prevent social isolation
  - children e.g. appropriate input/output devices, involvement in design process
- Cultural differences
  - influence of nationality, generation, gender, race, sexuality, class, religion, political persuasion etc. on interpretation of interface features
  - e.g. interpretation and acceptability of language, cultural symbols, gesture and colour
    - positive and negative? ✓ ✗

30


HUMAN-COMPUTER
INTERACTION
Summary
• Universal design is about designing systems that are accessible by all users
• Universal design helps everyone including people with no special needs
• Multi-modal systems provide access to system information and functionality through a range of input and output channels
• For any design choice we should ask ourselves whether we exclude someone or there are potential confusions and misunderstandings in our choice

31